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EXAMINER	
LEE, SHUN K	
ART UNIT	**PAPER NUMBER**
2878	

DATE MAILED: 02/23/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/056,437	CHO ET AL.
	Examin r	Art Unit
	Shun Lee	2878

Ac

-- The MAILING DATE of this communication app ars on the cover sheet with the correspondenc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 23 January 2002.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-19 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-19 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 23 January 2002 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Priority

1. Applicant has not complied with one or more conditions for receiving the benefit of an earlier filing date under 35 U.S.C. 120 as follows:

An application in which the benefits of an earlier application are desired must contain a specific reference to the prior application(s) in the first sentence of the specification or in an application data sheet (37 CFR 1.78(a)(2) and (a)(5)). The specific reference to any prior nonprovisional application must include the relationship (*i.e.*, continuation, divisional, or continuation-in-part) between the applications except when the reference is to a prior application of a CPA assigned the same application number.

2. If applicant desires priority under 35 U.S.C. 120 based upon a previously filed application, specific reference to the earlier filed application must be made in the instant application. For benefit claims under 35 U.S.C. 120, 121 or 365(c), the reference must include the relationship (*i.e.*, continuation, divisional, or continuation-in-part) of the applications. This should appear as the first sentence of the specification following the title, preferably as a separate paragraph unless it appears in an application data sheet. The status of nonprovisional parent application(s) (whether patented or abandoned) should also be included. If a parent application has become a patent, the expression "now Patent No. _____" should follow the filing date of the parent application. If a parent application has become abandoned, the expression "now abandoned" should follow the filing date of the parent application.

If the application is a utility or plant application filed under 35 U.S.C. 111(a) on or after November 29, 2000, the specific reference must be submitted during the pendency of the application and within the later of four months from the actual filing date of the application or sixteen months from the filing date of the prior application. If the application is a utility or plant application which entered the national stage from an international application filed on or after November 29, 2000, after compliance with 35 U.S.C. 371, the specific reference must be submitted during the pendency of the application and within the later of four months from the date on which the national stage commenced under 35 U.S.C. 371(b) or (f) or sixteen months from the filing date of the prior application. See 37 CFR 1.78(a)(2)(ii) and (a)(5)(ii). This time period is not extendable and a failure to submit the reference required by 35 U.S.C. 119(e) and/or 120, where applicable, within this time period is considered a waiver of any benefit of such prior application(s) under 35 U.S.C. 119(e), 120, 121 and 365(c). A priority claim filed after the required time period may be accepted if it is accompanied by a grantable petition to accept an unintentionally delayed claim for priority under 35 U.S.C. 119(e), 120, 121 and 365(c). The petition must be accompanied by (1) the reference required by 35 U.S.C. 120 or 119(e) and 37 CFR 1.78(a)(2) or (a)(5) to the prior application (unless previously submitted), (2) a surcharge under 37 CFR 1.17(t), and (3) a statement that the entire delay between the date the claim was due under 37 CFR 1.78(a)(2) or (a)(5) and the date the claim was filed was unintentional. The Director may require additional information where there is a question whether the delay was

unintentional. The petition should be addressed to: Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Information Disclosure Statement

3. The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

Drawings

4. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: 119. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

5. The drawings are also objected to because it is unclear which curve is 2D electron gas and which curve is energy band in Figs. 11a and 11b. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

6. Figures 2 (see pg. 3) and 3 (see last paragraph on pg. 4) should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

7. Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

8. The abstract of the disclosure is objected to because of the length and the language. Correction is required. See MPEP § 608.01(b).

9. The disclosure is objected to because of the following informalities: on pg. 1, “25” in line 25 should probably be deleted. Appropriate correction is required.

10. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Objections

11. Claim 3 is objected to because of the following informalities:

(a) in claim 3, "channels of carriers" on line 4 should probably be --channels of carriers in at least one conduction path layer-- and "at least one conduction path layer" on line 10 should probably be --said at least one conduction path layer--;

(b) in claim 3, "at least one quantum dot layer" on lines 6-7 should probably be --said at least one quantum dot layer--;

(c) in claim 3, "a horizontal direction" on line 13 should probably be --a horizontal direction which is parallel to said at least one conduction path layer--;

(d) in claim 3, "detect electrodes" on line 22 should probably be --said at least two detect electrodes--; and

(e) in claim 3, "carriers" on line 23 should probably be --said carriers--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

12. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

13. Claims 11, 12, 15, and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 11 recites the limitation "the bottom layer" in line 4. There is insufficient antecedent basis for this limitation in the claim.

Claim 12 recites the limitation "the bottom layer" in lines 2-3. There is insufficient antecedent basis for this limitation in the claim.

Claim 15 recites the limitation "the bottom layer" in line 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 17 recites the limitation "the bottom layer" in line 4. There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 103

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

15. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

16. Claims 1-3, 5-10, 13, and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iafrate *et al.* (US 4,821,093) in view of Esaki *et al.* (US 5,079,601).

The specification discloses (pg. 20, lines 6-16) that "Once carriers are released from the quantum dot layer by absorbing photons, the carriers with electric charges (i.e., negative for electron) move spatially to the channel layer (conduction path layer) and the resulting vacancy in the quantum dot causes electric potential changes around the quantum dot region including the channel region. This is also the very reason why the quantum dots are placed near the channel in the present invention. The term "near the channel" means a distance wherein the quantum dots influence the potential of the channel by accumulating carriers in the channel layer". Thus within the context of the specification, the claim limitations "predetermined positions near" and "located near" is a distance that the photogenerated carriers <u>can transit so as to accumulate in the channel</u> (and there is an electric potential change in the channel due to the electric potential of the accumulated photogenerated carriers and the electric potential of the quantum dot vacancies).

In regard to claims **1** and **2**, Iafrate *et al.* disclose a materialization method of a photo detect device, in which the transfer and channels of carriers are set in the horizontal direction by heterointerfaces, insulator/semiconductor interfaces and impurity doping and the magnitude of the currents which flow through the channels is determined by the control of Fermi level (see gate electrode 28 in Fig. 1 and column 1, lines 18-49), comprising the steps of:

(a) forming an absorption layer at predetermined position near the channels so as to influence the potential of the channels in such a manner that the carriers should be

released from the absorption layer in response to light detection and accumulated in the channels (column 7, lines 37-51); and

(b) providing the Fermi level at an activation position by confining the carriers within the absorption layer while limiting the number of the carriers in the channels for the purpose of minimizing a current flow in the absence of incident light (column 7, lines 37-51).

The method of lafrate *et al.* lacks that the light absorption layer comprise of quantum dot layers for infrared (*i.e.*, wavelength from 0.77 μm to 100 μm) light detection. However, photodetectors comprising nanostructures (*e.g.*, quantum wells, quantum wires, quantum dots) are well known in the art. For example, Esaki *et al.* teach an absorption layer comprising of nanostructures which produce reduced dimensionality electronic states (*e.g.*, quantum wells, quantum wires, quantum dots; column 8, lines 24-30) in order to have optical transition occurring between electron states in the conduction band (or hole states in the valence band; column 2, lines 35-39) so as to absorb light from the near to the far infrared (column 2, lines 26-29). Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide a light absorption layer comprising of quantum dots in the method of lafrate *et al.*, in order to detect light from the near (*e.g.*, 0.77 μm) to the far infrared (*e.g.*, 100 μm) as taught by Esaki *et al.*

In regard to claim **3**, lafrate *et al.* disclose (Fig. 1) a photo detect device comprising:

(a) at least one light absorption layer (12) located near channels of carriers in at least one conduction path layer (30) so as to influence the potential of the channels (*i.e.*, the carriers are released from the absorption layer in response to light detection and accumulated in the channels; column 7, lines 37-51);

(b) said at least one conduction path layer (30) in contact with the at least one light absorption layer (12), in which carriers excited in the light absorption layers (12) are collected and conducted in a horizontal direction;

(c) at least two detect electrodes (24, 26) for conducting in the horizontal direction the carriers which are accumulated in the channels (30) in response to the light incident on the at least one light absorption layer (12); and

(d) one contact layer (22) on which detect electrodes (24, 26) are formed to collect and to provide carriers.

The device of Iafrate *et al.* lacks that the light absorption layer comprise of quantum dots with carriers provided by at least one impurity-containing layer. However, photodetectors comprising nanostructures (*e.g.*, quantum wells, quantum wires, quantum dots) are well known in the art. For example, Esaki *et al.* teach a light absorption layer comprising of nanostructures which produce reduced dimensionality electronic states (*e.g.*, quantum wells, quantum wires, quantum dots; column 8, lines 24-30) in order to have optical transition occurring between electron states in the conduction band (or hole states in the valence band; column 2, lines 35-39) so as to absorb light from the near to the far infrared (column 2, lines 26-29). That is, Esaki *et al.* teach that a photon (with energy $\hbar\omega$) is absorbed in the conduction band of

a light absorption layer when an electron in an electron state with energy E_1 makes an optical transition to an unoccupied electron state with energy E_2 ($E_2 = E_1 + \hbar\omega$). Esaki *et al.* also teach that electron state with energy E_1 must be populated with electrons in order for the optical transition to occur (*i.e.*, arrangement of the band and Fermi levels, for example by applying a bias voltage, so that electrons move from another layer into the electron state with energy E_1 of the absorption layer; column 6, lines 59-63). Thus, Esaki *et al.* teach that the absorption layer with electron state with energy E_1 should be populated with electrons and electron state with energy E_2 should be unoccupied so that an optical transition can occurred in order to detect light from the near to the far infrared. Also, modulation doping (*i.e.*, carriers supplied to a layer by at least one impurity-containing layer) so as to provide carriers for the electron state with energy E_1 is well known in the art. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide a light absorption layer comprising of quantum dots and carriers supplied by at least one impurity-containing layer in the device of Iafrate *et al.*, in order to detect light from the near to the far infrared as taught by Esaki *et al.*

In regard to claim **5** which is dependent on claim 3, the device of Iafrate *et al.* lacks impurity-containing layers with a delta-doped structure. Esaki *et al.* teach that the absorption layer with electron state with energy E_1 should be populated with electrons and electron state with energy E_2 should be unoccupied so that an optical transition can occurred in order to detect light from the near to the far infrared (see above). Inherent in Esaki *et al.*'s teachings is that enough electrons must be provided to the absorption

layer in order to populate electron state with energy E_1 while leaving electron state with energy E_2 unoccupied. Thus, number of impurities in the impurity-containing layers is determined by the number of electrons needed to populate electron state with energy E_1 while leaving electron state with energy E_2 unoccupied. Impurity-containing layers with a delta-doped structure are well known in the art. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide impurity-containing layers with a delta-doped structure in the device of Iafrate *et al.*, in order to supply carriers from impurity-containing layers to the absorption layer so as to detect light from the near to the far infrared as taught by Esaki *et al.*

In regard to claim **6** which is dependent on claim 3, the device of Iafrate *et al.* lacks impurity-containing layers having a uniform distribution of the impurities therethrough and are etched to control the number of carriers provided to the quantum dots. Esaki *et al.* teach that the absorption layer with electron state with energy E_1 should be populated with electrons and electron state with energy E_2 should be unoccupied so that an optical transition can occurred in order to detect light from the near to the far infrared (see above). Inherent in Esaki *et al.*'s teachings is that enough electrons are provided to the absorption layer in order to populate electron state with energy E_1 while leaving electron state with energy E_2 unoccupied. Thus, number of impurities in the impurity-containing layers is determined by the number of electrons needed to populate electron state with energy E_1 while leaving electron state with energy E_2 unoccupied. The number of electrons supplied by impurity-containing layers is determined by the number of impurities. For a uniform distribution of the impurities,

the number of impurities is equal to the density of impurities times the volume of the impurity-containing layers. Thus, the number of electrons supplied by impurity-containing layers is determined by the density of impurities and the volume of the impurity-containing layers. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide impurity-containing layers with a uniform distribution of the impurities and an adjusted volume (*e.g.*, by etching) in the device of Iafrate *et al.*, in order to supply carriers from impurity-containing layers to the absorption layer so as to detect light from the near to the far infrared as taught by Esaki *et al.*

In regard to claims **7** and **8** which are dependent on claim 3, Iafrate *et al.* also disclose (Fig. 1) impurity-containing layers (14) and light absorption layers (12) formed adjacent (*e.g.*, overlapped) to conduction path layers (30).

In regard to claim **9** which is dependent on claim 3, Iafrate *et al.* also disclose that the impurity-containing layers and the light absorption layer are made to have different band gaps so as to be subjected to heterostructures (*i.e.*, heterojunction; column 1, lines 18-49). While Iafrate *et al.* further disclose that the conducting path layers is in the form of a two-dimensional electron gas (column 1, lines 18-49), the device of Iafrate *et al.* lacks an explicit description that the conducting path layers have a different band gap so as to be subjected to heterostructures. However it is well known in the art that two-dimensional electron gas occurs in a quantum well and that a quantum well is formed by band gap differences. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide conducting

path layers made to a different band gaps in the device of Iafrate *et al.*, in order to form a two-dimensional electron gas so as to have high electron mobility conducting paths as taught by Iafrate *et al.* (column 1, lines 18-49).

In regard to claim **10** which is dependent on claim 3, Iafrate *et al.* also disclose (Fig. 1) at least one control electrode (28) for controlling the amount of the carriers provided to the light absorption layers (12) and the conduction path layers (30).

In regard to claims **13** and **16** which are dependent on claim 10, Iafrate *et al.* also disclose a multiple gate high electron mobility field effect transistor in a photodetector configuration (see Figs. 2 and 8; and column 7, lines 37-51).

17. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iafrate *et al.* (US 4,821,093) in view of Esaki *et al.* (US 5,079,601) as applied to claim 3 above, and further in view of Bethea *et al.* (US 4,739,385).

In regard to claim **4** which is dependent on claim 3, the modified device of Iafrate *et al.* lacks an explicit description of the distance between the detect electrodes. Bethea *et al.* disclose that the detect electrodes (15, 19 in Fig. 1) have a distance therebetween which is greater than 2.5 μm to 120 μm (column 3, lines 7-9) in order to have good optical coupling efficiency (column 3, lines 13-16). Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide greater than 2.5 μm to 120 μm distance (*e.g.*, which is longer than a 0.77 μm incident light wavelength) between the detect electrodes in the modified device of Iafrate *et al.*, in order to have good optical coupling efficiency as taught by Bethea *et al.*

18. Claims 11, 12, 14, 15, 17, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iafrate *et al.* (US 4,821,093) in view of Esaki *et al.* (US 5,079,601) as applied to claims 10, 13, and 16 above, and further in view of Schiebel *et al.* (US 5,396,072).

In regard to claims **11** and **12** (which are dependent on claim 10), claims **14** and **15** (which are dependent on claim 13), and claims **17** and **18** (which are dependent on claim 16), the modified device of Iafrate *et al.* lacks a layer (*e.g.*, doped or highly resistant) provided below the bottom layer of the control electrodes to reduce leak currents of the control electrodes. The use of layers (*i.e.*, blocking layers) overlapping electrodes to block charge injection from the electrode (*i.e.*, leakage current) is well known in the art. For example, Schiebel *et al.* teach to provide a layer overlapping a electrode which is substantially not conductive to carriers of: (a) both polarities (column 3, lines 45-49) or (b) same polarity relative to the potential of electrode (column 3, lines 32-36). For example, for an electrode which will have both negative and positive voltages applied, a highly resistant layer (*i.e.*, a layer which is substantially not conductive to both electrons and holes) should be provided. As another example, for an electrode which will have a negative voltage applied, a p-type layer (*i.e.*, a layer which is substantially not conductive to electrons) should be provided. Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide a blocking layer below the control electrodes in the modified device of Iafrate *et al.*, in order to reduce leakage currents as taught by Schiebel *et al.*

19. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iafrate *et al.* (US 4,821,093) in view of Esaki *et al.* (US 5,079,601) and Chapple-Sokol *et al.* (US 5,293,050).

In regard to claim **19**, Iafrate *et al.* disclose a method for fabricating a photo detect device, comprising the steps of:

(a) growing light absorption layers (column 7, lines 37-51);

(b) depositing at least two electrode on a contact layers to show horizontal conduction (column 3, lines 3-5);

(c) reducing the resistance between the electrode and the contact layer (column 2, line 68 to column 3, line 2);

(d) etching the edge of the device to an extent necessary to reduce an electrical connection to other neighboring devices (column 6, lines 11-15); and

(e) depositing at least one control electrode (column 3, lines 5-9).

The method of Iafrate *et al.* lacks forming quantum dots naturally in the course of growing light absorption layers, controlling the amount of carriers provided to the quantum dots by adjusting the carrier supplying layer volume and the control electrode voltage, and depositing and etching an insulating film over the device. However, insulating films for integrated circuits (*e.g.*, FET) are well known in the art. That is, it would have been obvious to one having ordinary skill in the art to at the time of the invention provide an insulating film (*e.g.*, by depositing and etching) in the method of Iafrate *et al.*, in order for the device to function properly (*i.e.*, there is electrical isolation between electrodes). In addition, Esaki *et al.* teach a light absorption layer comprising

of nanostructures which produce reduced dimensionality electronic states (*e.g.*, quantum wells, quantum wires, quantum dots; column 8, lines 24-30) in order to have optical transition occurring between electron states in the conduction band (or hole states in the valence band; column 2, lines 35-39) so as to absorb light from the near to the far infrared (column 2, lines 26-29). That is, Esaki *et al.* teach that a photon (with energy $\hbar\omega$) is absorbed in the conduction band of a light absorption layer when an electron in an electron state with energy E_1 makes an optical transition to an unoccupied electron state with energy E_2 ($E_2 = E_1 + \hbar\omega$). Esaki *et al.* also teach that electron state with energy E_1 must be populated with electrons in order for the optical transition to occur (*i.e.*, arrangement of the band and Fermi levels, for example by applying a bias voltage, so that electrons move from another layer into the electron state with energy E_1 of the absorption layer; column 6, lines 59-63). Thus, Esaki *et al.* teach that the absorption layer with electron state with energy E_1 should be populated with electrons and electron state with energy E_2 should be unoccupied so that an optical transition can occurred in order to detect light from the near to the far infrared. Further, Chapple-Sokol *et al.* teach it is known in the art that quantum dots are naturally forming the growth of a photodetector (column 3, lines 4-38) for any type of photodetector (column 6, lines 36-39). Therefore it would have been obvious to one having ordinary skill in the art at the time of the invention to provide naturally formed quantum dots which are supplied with the appropriate amount of carriers by adjusting the carrier supplying layer volume and the control electrode voltage in the method of Iafrate *et al.*, in order to detect light from the near to the far infrared as taught by Esaki *et al.*

Conclusion

20. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. US patent 4,488,162 (Jambotkar) teaches it is known in the art that field effect transistor integrated circuits require (for proper functioning) electrical isolation between electrodes and devices especially as density of devices increase (column 3, lines 1-29). US patent 4,761,620 (Bar-Joseph *et al.*) teaches it is well known in the art to provide modulation doping so that carriers populate the electron state with energy E_1 in a quantum well (column 2, lines 11-19). US patent 5,285,514 (Nojiri *et al.*) teaches that light detecting unit having a field effect transistor structure is known in the art (column 1, lines 53-65) and that setting the voltage to the pinch-off voltage reduces dark current (*i.e.*, current flow in the absence of incident light; column 5, lines 46-64).

21. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shun Lee whose telephone number is (571) 272-2439. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Porta can be reached on (571) 272-2444. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CONSTANTINE HANNAHER
PRIMARY EXAMINER
GROUP ART UNIT 2878

SL